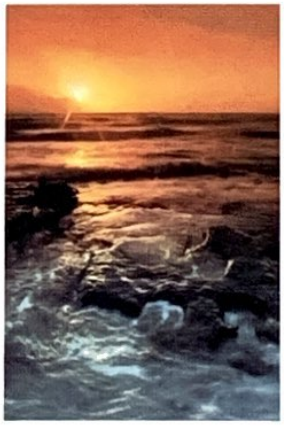
ALLIED Corporation

Strive for excellence
THE RELIABILITY APPROACH

Reliability Incidents Leader's Guide



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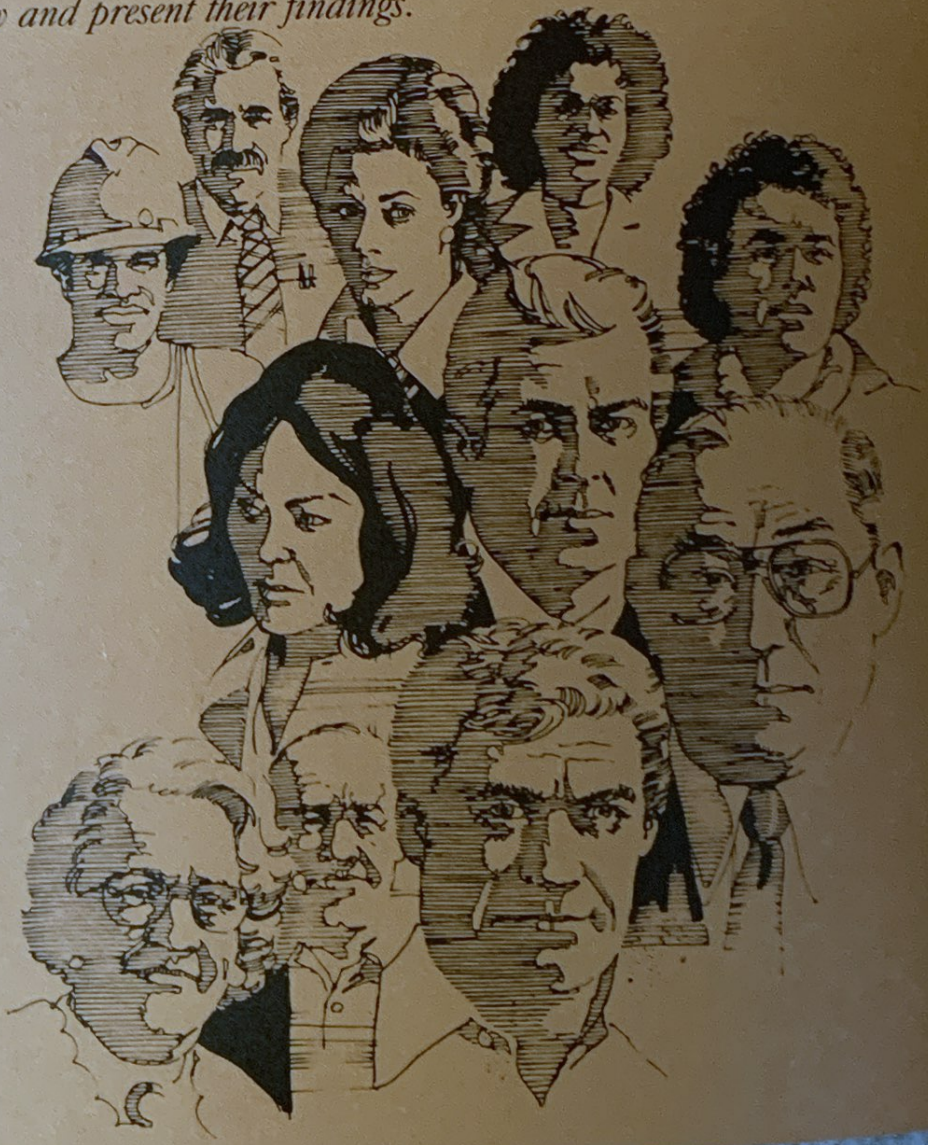
The format of this brochure includes discussion aids for each of the ten Reliability Incidents. First, the background of the incident is reviewed, and then the desired objectives are stated. This format is designed to aid front-line foremen and supervisory personnel in leading a discussion with their group.

Start by breaking the department into smaller groups of 2 to 4 people. Pick those incidents that best apply to the type of work these people do; then have each group review and present their findings.



1. Inventory Management – Discussion Aids

Background

Letting people get parts out of the storeroom without processing paperwork is a poor management practice and contrary to Corporate maintenance policy on stores central systems. One reason for stockouts is that if someone took the part without recording it, stores' records will indicate the part is still on hand. Also, that part probably hasn't been reordered, and depending on order points probably won't be reordered for some time to come. Letting people have parts without paperwork is like:

a. Lending neighbors your tools without recording who has what. If much time passes, when you need those tools you won't have any idea where to find them.

b. Running a business and letting people charge things without keeping any records. You can imagine how chaotic and costly that would be.

c. Operating your car without a gas gauge. You can never be quite sure when you are going to run out of gas.

Desired Objectives

To prevent people from getting parts without paperwork on the back shifts, every storeroom must have written procedures for issuing parts on the off shifts. Also, all off-shift storeroom users must be educated on the need for such a procedure and understand how the procedure works.

2. Process Upset – Discussion Aids

Background

We often take process upsets in stride as part of the job we have to deal with on an everyday basis. Recurring process upsets, however, just like recurrent equipment failures, need not and indeed should not be allowed to happen.

The first thing we must do to eliminate these annoying, usually costly, and sometimes dangerous events is to make sure that they are identified and then make sure that someone is made aware of them.

The best way to get people to do something about a problem is to thoroughly identify and document the nature of the problem. This will get more results than casually mentioning the problem, assuming someone else will worry about it. Be an alert observer. Just as in a good cops and robbers movie, if the victim can't describe the villain it doesn't give the good guys much to work on. Take note on conditions observed before, during and after the event.

Make every safe effort to continue collecting prescribed logsheet data, since this may be the very clue needed by the investigators to identify the root cause of the problem (i.e. did the temperature go up before or after the incident? Was the pressure drop a result of or a cause of the event? etc.).

Another important piece of information which you can contribute to the elimination of such problems is to keep track of the frequency and severity of the problem. This information helps in assigning a priority status to your problem. Very often the reason problems don't get the attention they should is that their priority is not apparent. An upset which occurs once every two years is not deserving of the same attention as a problem of the same nature which occurs every two months.

Sometimes we get frustrated that someone is not doing anything about our problem even though we told them about it. When that happens we may not bother to alert anyone to the problem recurrences. This, of course, creates the illusion that the problem no longer exists and for sure nothing will be done. Don't give up! When upsets occur, alert someone and make a note of it. That way you have the evidence to bring attention to bear on the problem and the problem solvers have the information they need to address the most important problems first.

Desired Objectives

What can we do to make sure that we give these upsets the appropriate attention as described above?

- Become more sensitive to normal versus abnormal operating conditions.
- If you don't understand a behavior or unusual signal from your machine or process, don't hesitate to ask your supervisor for advice.
- Have graphs or control charts established for key variables.
- Make a list of upset conditions upon which you want to concentrate.
- Take the time to communicate potential problems, providing as much supportive data as possible to give your problem credibility.

3. Data Analysis – Discussion Aids

Background

Data recording can become a seemingly thankless chore in our jobs. Very often it seems we are doing it for a fruitless exercise and that no one really uses it except to check up on us. Actually, data about the machines, processes and products which Allied manufactures are one of the company's most important assets. It is the stuff of which future process and product improvements can grow as well as the means to keep the current system running smoothly. Data, or more importantly, information derived from the data you record is essential to tell us where we are, how we got there, and, most importantly, where we are going.

This doesn't happen by itself however. The numbers which you write down or punch into a computer are just the beginning of this effort to transform data into decision-making information about whether the equipment is running correctly, the product quality is high or the raw material is good or bad. *You* are the first person to begin processing this data into decision information. As you take readings, *you are the first point at which decisions can be made to react to the data*. If you let the signals pass you by and do not react, the potential value of the data is lost. Through your timely interpretation of this data, valuable time can be saved by identifying undesirable trends or events. If you THINK about what the data is telling you and ALERT your supervisor to any unusual conditions, you can make the data start to pay off right away.

The next step in this transformation of data to information takes place after you have recorded the data (and hopefully reacted to it as necessary) and handed in your logsheets. At this point, those numbers may be plotted on charts to look for trends and patterns which may warn of impending problems. They may be analyzed by sophisticated computer programs to identify the relationships between the dozens of variables so that improvements can be made in yields, qualities, and process performance. They may be used as input to numerous management reports to provide information for daily decisions on how much to make, what to fix, and when to change plans.

All of these uses of data, however, are stymied if the quality of the data right at the end of your pencil is poor or incomplete. *You* are the *source* of this potentially valuable asset called data. Your diligence can determine whether this asset will be capable of producing its potential return on investment of your time and all of the other efforts which go into transforming data into information.

Desired Objectives

What can we do to make sure that the data which we collect is utilized to its fullest potential?

- Have process supervisors or engineers explain what the data means and how it is used after you record it.
- Ask yourself as you collect the data what it is telling you.
- Establish plots and graphs in your area so that you can get a better feel for what the trends and patterns are in your data and so you can better react appropriately when they appear.
- Take all readings at required intervals.
- Double check readings.
- Use adequate writing instruments (sharp pencils, functional pens).
- Protect logsheets when they must be taken into harsh environments.
- Ask for a list of acceptable ranges for readings.
- Alert supervisor to anything unusual.
- Make list of most important readings requiring your special attention.
- Suggest changes in logsheet format if they would make it easier to detect cause and effect relationships.
- Encourage the use of computer or electronic data collection tools if it makes the job of capturing and analyzing data easier.

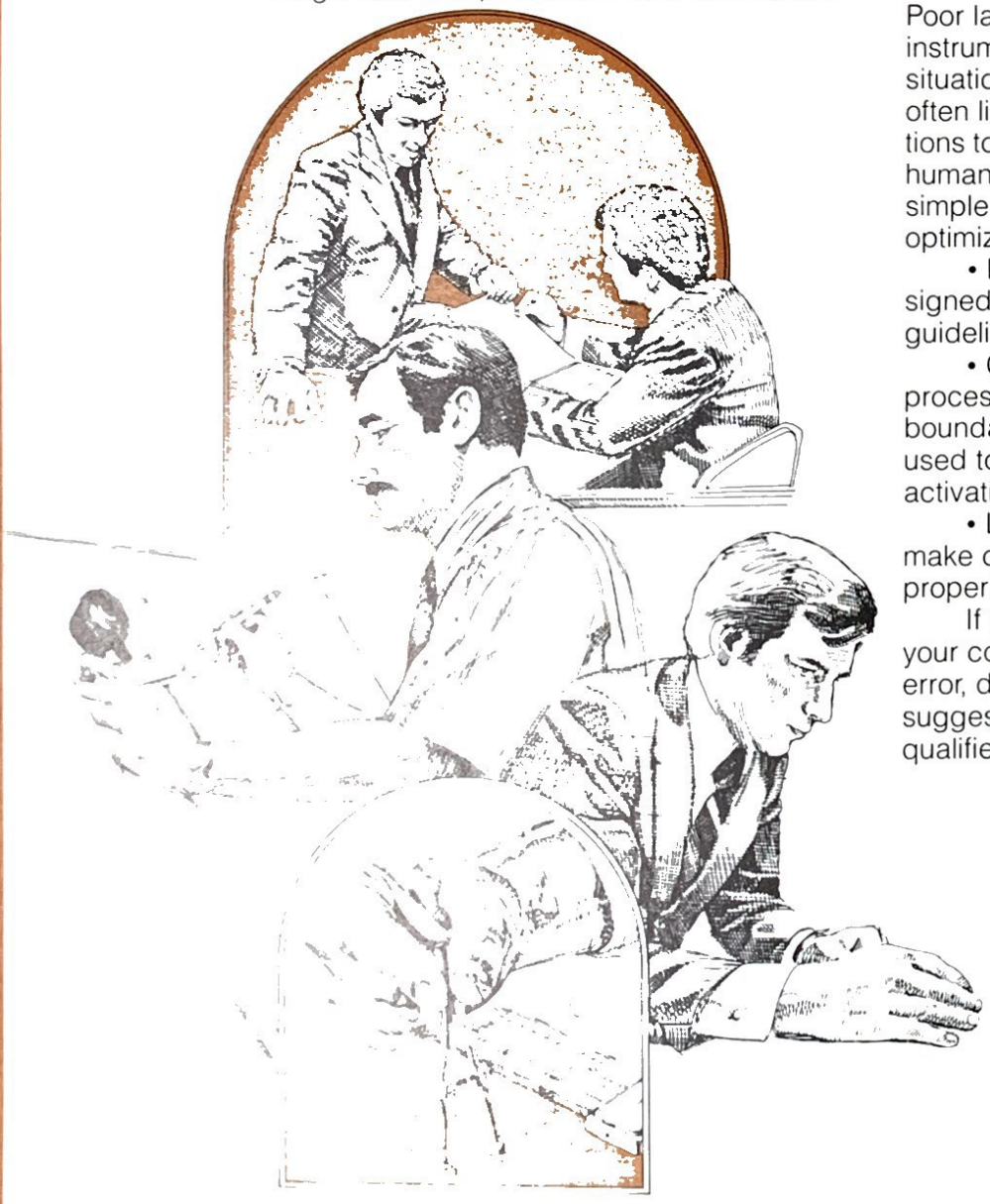
4. *Human Factors Engineering – Discussion Aids*

Background

Although fatigue and stress would certainly have to be considered contributing factors in the operator's error, the overriding contributor is the layout of the control board. A control room designed to good human factors standards should be somewhat forgiving of such factors as operator stress, fatigue, etc. and in fact should be designed with these situations in mind. Critical controls, readouts, gauges, etc. should be designed and arranged in such a manner as to minimize the potential for human error in crisis situations, not increase it as this one did.

Arrangement of the pump controls in a single row, with poor labels and inadequate spacing created a situation that was actually conducive to error, even under normal conditions.

In day-to-day situations, this would be analogous to storing the tube of "Deep Heat" next to the tube of "Preparation H" in the bathroom cabinet and picking up the wrong one by mistake; or storing gasoline and charcoal lighter in similar containers and setting them side by side on the shelf; or perhaps placing your prescription medicine in the same area as the children's medication. In each case, the wrong choice could lead to disastrous results.



Desired Objectives

Poor layout and design of control board instruments and controls is not an uncommon situation. In existing control rooms there is often little opportunity to perform modifications to the control board to achieve a sound human factors design, but there are some simple improvements that can be made to optimize what you have.

- Labels, for example, can be redesigned according to human factors guidelines on print, color, letter size, etc.
- Controls can be grouped according to process section by enclosing them with color boundaries, or other location aids can be used to reduce the chance of inadvertently activating the wrong control.
- Lighting levels can also be checked to make certain the controls and labels are properly illuminated.

If you have encountered problems in your control room that could lead to human error, discuss them with your supervisor and suggest that an evaluation be made by a qualified human factors expert.

MECHANICAL EQUIPMENT BREAK DOWNS...

Background

The hourly maintenance functions should be that of repairing, adjusting, and cleaning a device to get it back on-line as soon as possible — using sound maintenance procedures.

The mechanic should not be expected to *determine* the precise cause of the problem — he should concentrate his efforts on a quality repair thereby getting the machine back on-line as quickly as possible.

Aside from the supervision required to make any major decisions concerning the repair, the *failure analyst* needs to be at the scene as soon after the equipment goes down as possible. This failure analyst should not be involved in the repair procedure, but rather should be taking pictures, gathering failed parts, asking questions and accumulating other facts necessary to perform the analysis. *Observing the step-by-step disassembly of a failed piece of equipment is one of the most important phases of a failure analysis!* If a plant is too small to have a failure analyst on staff someone should take the necessary photographs, assemble failed components and make pertinent notes which can be sent to an analyst for review. This should be done for all critical repairs.

Desired Objectives

- Sensitivity to issue of root cause failure analysis.
- Knowledge of who would be available for analysis.
- Knowledge of what to save if analyst is not available.
- Knowledge as to what the analyst can do. (Stress analysis, metallurgical analysis, fracture mechanics, etc.)
- Willingness to work with the analyst or his surrogate when critical failures occur.
- Willingness to contribute information regarding operating conditions and repair observations to the analyst.

8. Equipment Monitoring – Discussion Aids

Background

Yes, the cleanup crew should definitely tell someone about the observed change in vibration level of that bearing because for operating machinery a change in vibration level is an early warning sign of a more serious problem. Just like a change in blood pressure is often an early warning sign of a more serious problem in humans, machinery, too, gives indications of when it has a problem. *One key to a successful reliability program is knowing what these symptoms are* (vibration, temperature, noise level, etc.) *and what to do about them.* The key to good health is frequent monitoring of bodily indicators (temperature, pulse, respiration, blood pressure, etc.) and a key to improved equipment reliability is frequent monitoring of the machine condition indicators.

We all know that equipment is going to need maintenance. We also know that some failures cause much more damage than other failures, even though they may have the same root cause. For example, if bad bearings are allowed to run so long that they freeze up, we may have a bent or broken shaft and other damage caused when the broken shaft went flying. The secondary failures and their associated downtime and cost could have been prevented if the bearing had been replaced when it first showed signs of failure.

Corporate Maintenance Policy suggests the use of predictive maintenance techniques such as an equipment monitoring program to detect failures before they become expensive and lead to potentially dangerous secondary failures. An equipment monitoring program utilizes a schedule for inspection and a list of equipment to be inspected that takes into consideration the value of that equipment, the cost of repairing that equipment, the cost of a shutdown of that equipment, the failure modes to be detected, and the rate at which a failure proceeds. By necessity, the equipment is monitored only at selected times.

Desired Objectives

- Equipment monitoring and failure prediction depends upon detection of changes in equipment condition.
- Changes in equipment condition are manifested in higher vibration levels, more noise, higher temperature, unusual odor, etc.
- Observed changes in equipment condition should always be reported.
- Confining failures to the primary failure is much better than allowing progression to secondary failures.
- Equipment monitoring is the responsibility of everyone in a plant.
- A formal procedure for reporting plant failures should be developed and communicated to all plant personnel.
- Equipment monitoring is one part of a predictive maintenance program suggested by the Corporate Maintenance Policy.

9. Equipment Failure Prediction – Discussion Aids

Background

From a standpoint of preventing accidents, reducing property losses, and minimizing downtime, prediction of impending failures is a reliability program's greatest asset short of eliminating failures completely. If we fail to react to the early signals of impending failures, this asset is wasted.

Reliability inspectors use the latest technology available to monitor equipment condition and predict when failures are imminent. They also try to forecast how much time is available before the failure actually occurs by assigning priorities to impending failures. A "medium priority" indicates that several days are available to schedule a repair. This lead time to repair allows management time to come up with creative techniques for minimizing downtime and repair time. While two hours seem like a very short time to repair a river water pump, the lead time provided by early prediction makes it possible to try. Arrangements can be made to get many things ready beforehand to expedite the repair process. This certainly beats having a failure occur unexpectedly and then trying to make all of the arrangements. You as an observer should point this out to the operating foreman who will be appreciative of your viewpoint.

Some plants in the corporation have reliability inspection programs for process equipment. These programs consist of weekly inspections of all operating equipment with hand-held vibration meters, pyrometers, pulse shock meters, or strobe lights. The purpose of the inspections is to determine if the condition of the machine has changed since last week's inspection. Changes in vibration, temperature, or any other parameter indicates problems with machines that are in early stages of trouble.

By responding to these early indications of problems our maintenance jobs are relatively small such as changing out worn bearings, rebalancing, realigning, or replacing worn parts. If we do not discover machinery problems in the early stages the machine may come apart or seize and the maintenance repair job is much more serious. They may include repairing or replacing of housings, rebuilding or replacing shafts and rotors, or complete replacement of the machine.

Desired Objectives

The objective of an equipment failure prediction program is to get every employee in a plant to be aware of the value of discovering machinery problems in the early stages. Whether a plant does or does not have a reliability inspection program, each employee from time to time will observe a questionable machinery operating condition. They should be encouraged to mention these observations to supervision. Supervision will be responsive to legitimate problems and let the employee know what is determined concerning his or her observation.

10. Tool Inspection Program – Discussion Aids

Background

The plant where this accident occurred has a tool inspection program. Electric power tools and their cords are electrical ground checked monthly. The tool's power cord is then marked with a color-coded piece of tape on which is printed the month and year. Many different colors of tape are used so that a person can tell at a glance the month in which a power tool was last checked, and a closer inspection will determine the exact month and year.

An inspection program of this type should greatly improve the reliability of powered hand tools and should greatly reduce the possibility of an electrical shock from using such tools. Since an injury occurred even with a program of this type, a more detailed investigation was required.

The drill motor involved in the accident was taken to the tool room and checked in the electrical test stand. It was found to have an electrical short in the drill motor housing. The power cord was not marked with color-coded tape. It was suspected that the drill motor had never been tested.

A check with the injured employee revealed that this was the case. He said that he had checked that drill motor out of the tool room on "permanent loan" several years ago and kept it in his tool box. He said he had heard something about a tool inspection program but was not aware that he had to take his electric drill to the tool room monthly to be checked. Besides, he worked rotating shifts and the tool room was only open on the day shift making it difficult to coordinate getting the drill motor checked.

However, since he was injured from using a faulty drill, this employee will probably always remember to get his power tools checked periodically in the future; but what about other employees in similar situations? Are they aware of the tool inspection program, and will they get their power tools checked periodically?

One plant faced with this situation took the following actions:

1. Foremen check their employees' tool boxes annually. Every tool is checked including hammer handles for cracks and wear, chisels for mushroomed heads, and power tools for current inspection markings. Small prizes such as a silver dollar are sometimes awarded when no defects are found, and the tool box is marked with a sticker to show when it was inspected.

2. Frequent reminders to get their power tools checked are often attached to the employee's payroll check.

3. The reasons for getting power tools checked periodically are often discussed in safety meetings.

These are just a few things that can be done to publicize an electrical power tool inspection program. Perhaps you can think of many others. The important point to remember is that a power tool inspection program is only effective if everyone participates and follow-up is continual.

Desired Objectives

The objective of a tool inspection program is to reduce the possibility of injury caused by defective tools. Just initiating such a program will not meet this objective. This objective can only be met when:

- A tool inspection-reinspection program is put into use.
- Everyone is made aware of the need for such a program.
- The procedure for getting tools inspected and reinspected is communicated to and understood by everyone involved in the program.
- The inspection program is adequately publicized.
- There is continual management follow-up on the activities of the program.

By the mystery of his intellect, mankind has brought reliability to machines similar to nature's ancient rhythms of day and night or rolling tides.